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UDC 621·43 - 242 [669·715]
(First Reprint APRIL 1992)
IS : 8503 - 1986

(Reaffirmed 2006)

Indian Standard

TECHNICAL SUPPLY CONDITIONS FOR ALUMINIUM ALLOY PISTONS FOR INTERNAL COMBUSTION ENGINES

(First Revision)

1. Scope — Covers the technical supply conditions for forged and cast aluminium alloy pistons for internal combustion engines.

2. Material — Pistons shall be manufactured from low expansion aluminium silicon alloys. Suitable materials for the manufacture of pistons are given in IS : 7793-1975 'Specification for aluminium alloys for IC Engine pistons'.

2.1 In case the pistons are to be subjected to severe thermal loading, such as, in two-stroke application, or in high compression engines, special hyper-eutectic aluminium-silicon alloys with very low coefficient of expansion, having silicon contents of 18 percent and for more severe applications with silicon content of up to 25 percent, are recommended.

2.1.1 Alloys other than those specified above may be used subject to agreement between the purchaser and the manufacturer.

2.2 The aluminium-silicon alloys shall be suitably treated and modified to ensure uniform distribution of silicon particularly in hyper-eutectic alloys.

2.3 The hardness of the pistons in the fully heat-treated condition shall be 90 to 125 *HB* 10/5 (28 to 50 *HRB* 5/250).

2.3.1 For conversion of hardness values from Rockwell B to Brinell as applicable to aluminium alloy pistons, the relationship given in Table 1 may be referred to.

TABLE 1 RELATIONSHIP BETWEEN ROCKWELL (*HRB* 5/250) AND BRINELL (*HB* 10/5) HARDNESS VALUES FOR ALUMINIUM ALLOY PISTONS

Rockwell Hardness *HRB* 5/250	Actual Brinell Hardness *HB* 10/5	Rockwell Hardness *HRB* 5/250	Actual Brinell Hardness *HB* 10/5
21	80·7	43	112·1
22	82·0	44	113·8
23	83·3	45	115·6
24	84·6	46	117·4
25	85·9	47	119·2
26	87·2	48	121·1
27	88·5	49	123·0
28	89·8	50	125·0
29	91·1	51	127·0
30	92·5	52	129·0
31	93·9	53	131·1
32	95·3	54	133·3
33	96·7	55	135·6
34	98·1	56	138·0
35	99·6	57	140·5
36	101·0	58	143·2
37	102·5	59	146·1
38	104·0	60	149·3
39	105·6	61	152·9
40	107·2	62	157·1
41	108·8	63	163·0
42	110·4		

Internal Combustion Engines Sectional Committee, EDC 14; Piston Assembly Components Subcommittee, EDC 14 : 1 [Ref : Doc : EDC 14 (4613)]

Adopted 26 November 1986
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NEW DELHI 110002

2.3.2 For other types of alloys, the hardness shall be as agreed to between the purchaser and the manufacturer.

2.4 Suitable heat treatment may be carried out for piston blanks for volumetric stability.

3. Piston Design — The basic design of the piston depends on the special characteristics of the engine or on severity of application. The nomenclature, however, applicable to the piston types, various part of the piston and the essential dimensions shall be as given in 3.1 to 3.4.

3.1 The nomenclature of commonly used piston types and various parts of the piston is given in Appendix A.

3.2 The nomenclature for essential piston dimensions is given in Appendix B.

3.3 The recommended tolerances for the leading dimensions of the piston are given in Appendix C.

3.4 *Piston oversize, wherever applicable, shall be in the steps of 0·2 or 0·25 mm.*

4. Ring Groove Dimensions and Clearances

4.1 *Ring Groove Widths*

4.1.1 *Parallel sided grooves* — Parallel sided ring groove widths shall be as specified in Tables 2 and 3. When compression and oil control rings having the widths specified in Tables 2 and 3 respectively are assembled in these grooves, the minimum side clearances shall be as specified in Table 4.

4.1.2 Any deviation of the side clearances required for special applications shall be obtained by altering piston ring groove width and not by changing the piston ring widths.

TABLE 2 TOP COMPRESSION RING GROOVE WIDTHS H_1 IN RELATION TO RING WIDTHS AND NOMINAL CYLINDER BORE

All dimensions in millimetres.

Nominal Ring Width h_1	H_1					
	Nominal Cylinder Bore, $d_1 > 30 \leqslant 100$				Nominal Cylinder Bore, $d_1 > 100$	
	Spark ignition		Compression ignition		Spark Ignition and Compression Ignition	
	Max	*Min*	*Max*	*Min*	*Max*	*Min*
1 5	1 555	1·530	1·580	1·555	—	—
2·0	2·055	2 030	2·080	2·055	2 080	2 055
2·5	2 555	2·530	2 580	2·555	2 580	2·555
3 0	3 055	3 030	3 080	3·055	3·080	3·056
3 5	—	—	—	—	3 580	3 555
4·0	—	—	—	—	4 080	4·055

Note — The groove widths are calculated using the side clearances given in Table 4 and ring width h_1.

4.2 *Taper Sided Grooves*

4.2.1 Taper sided ring groove width shall be as specified in Tables 5 and 6 respectively When 6° or 15° keystone rings having the widths specified in Tables 5 and 6 respectively are assembled in these grooves, the minimum side clearances when the piston ring is flush with the piston land immediately above the groove, taken on the bottom limit of the minor axis shall be as given in Table 7. The measurements are taken when the piston and gauge are at standard temperature.

4.2.2 Any deviation of the side clearances required for special applications shall be obtained by altering piston ring groove widths and not by changing the piston ring widths.

TABLE 3 LOWER COMPRESSION AND OIL CONTROL RING GROOVE WIDTH, H_1 IN RELATION TO RING WIDTH, h_1 AND NOMINAL CYLINDER BORE, d_1

(*Clause* 4.1.1)

All dimensions in millimetres.

Nominal Ring Width, h_1	H_1			
	Spark Ignition and Compression Ignition			
	Nominal cylinder bore, d_1 $> 30 \leq 100$		Nominal cylinder bore, d_1 > 100	
	Max	*Min*	*Max*	*Min*
1·5	1·555	1·530	—	—
2·0	2·055	2·030	2·055	2·030
2·5	2·555	2·530	2·555	2·530
3·0	3·055	3·030	3 055	3·030
3·5	—	—	3·555	3·530
4·0	4·055	4·030	4·055	4·030
4.5	4·555	4·530	—	—
5·0	5·055	5·030	5 055	5·030
6·0	—	—	6 055	6·030
7·0	—	—	7·052	7·027
8·0	—	—	—	—

Note — The groove widths are calculated using the side clearances given in Table 4 and the ring width h_1.

TABLE 4 COMPRESSION AND OIL CONTROL RING MINIMUM SIDE CLEARANCES

(*Clause* 4.1.1)

All dimensions in millimetres.

Nominal Cylinder Bore, d_1	Spark Ignition Engines		Compression Ignition Engines	
	Top Groove	Lower Compression and Oil Ring Grooves	Top Groove	Lower Compression and Oil Ring Grooves
Up to 100	0·040	0·040	0·065	0·040
Above 100	0·065	0 040	0·065	0·040

Note — *The scraper ring being a dual purpose ring would normally be fitted with compression ring side clearance.*

TABLE 5 6° KEYSTONE RING GROOVE WIDTH H_3 AT MEASURING POINT

(*Clause* 4.2.1)

All dimensions in millimetres.

Nominal Ring Width, h_3	H_3							
	Nominal Cylinder Bore, d_1							
	70 to 88		90 to 124		125 to 168		170 to 200	
	Max	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*
2·0	1·933	1.908	—	—	—	—	—	—
2·5	2·433	2·408	2 433	2·408	—	—	—	—
3·0	—	—	2·933	2·908	2·933	2·908	—	—
3·5	—	—	—	—	3·433	3·408	3·433	3·408
4·0	—	—	—	—	—	—	3·933	3·908

Note — The groove widths are calculated using the side clearance given in Table 7 and the ring width h_3.

TABLE 6 15° KEYSTONE RING GROOVE WIDTH H_3 AT MEASURING POINT

(*Clause* 4.2.1)

All dimensions in millimetres.

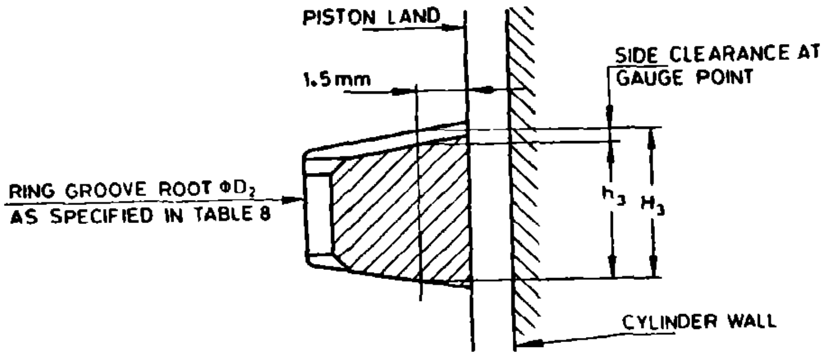
Nominal Ring Width, h_3	H_3							
	Nominal Cylinder Bore, d_1							
	82 to 98		*100 to 124*		*125 to 168*		*170 to 200*	
	Max	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*
2·5	2·160	2·135	—	—	—	—	—	—
3·0	2·660	2·636	2·660	2·635	—	—	—	—
3·5	—	—	3·168	3·135	3·160	3·135	—	—
4·0	—	—	—	—	3·660	3·635	3·660	3·636
4·5	—	—	—	—	—	—	4·160	4·135

Note — The groove widths are calculated using the side clearances given in Table 7 and ring width h_3.

TABLE 7 6° AND 15° KEYSTONE RING MINIMUM SIDE CLEARANCES

(*Clause* 4.2.1)

All dimensions in millimetres.


PISTON LAND
1.5mm
SIDE CLEARANCE AT GAUGE POINT
RING GROOVE ROOT ΦD₂ AS SPECIFIED IN TABLE 8
h₃
H₃
CYLINDER WALL

Type of Ring	*Minimum Side Clearance at Gauge Point*
6° Keystone	0·076
15° Keystone	0·040

4.3 *Ring Groove Root Diameters*

4.3.1 Ring groove root diameters shall be as specified in Table 8 and are calculated from the following:

Compression ring grooves:

$$D_2 = d_1 - (2a_1 + 0{\cdot}006d_1 + 0{\cdot}50)$$

Oil control ring grooves:

$$D_2 = d_1 - (2a_1 + 0{\cdot}006d_1 + 1{\cdot}50)$$

where

D_2 is the maximum ring groove root diameter

d_1 is the nominal cylinder bore or ring diameter.

a_1 is the maximum radial wall thickness given in col 2 of Table 8.

Note 1 — For rings of intermediate sizes and oversizes for reboring, the ring groove root diameters of the next smaller nominal bore are increased by the amount of oversize.

Note 2 — The scraper ring being a dual purpose ring would normally be fitted with compression ring groove root diameter.

Note 3 — The tolerance on D_2 is − 0·250 mm.

4.3.2 Alternatively, ring groove root diameter may be calculated using the following formula:

$D_2 = d_1 -$ [2 a_1 + piston diametral clearance +
groove eccentricity (TIR) + 2 × *Max*
groove root radius + 2 × desired extra
back clearance]

where D_2, d_1 and a_1 have the same connotation as in 4.3.1.

4.3.3 Dimensions for ring groove root corner radii for aluminium alloy pistons are given below:

Type of Engine	*Groove Root Corner Radius*, mm
Spark ignition	0·00 to 0·20
Compression ignition with nominal cylinder bore d_1 up to and including 150 mm	0·200 to 0·400
Compression ignition with nominal cylinder bore, d_1 above 150 mm	0·400 to 0·500

TABLE 8 TYPICAL RING GROOVE ROOT DIAMETER SIZES IN RELATION TO NOMINAL CYLINDER BORE AND MAXIMUM RING RADIAL WALL THICKNESS

(*Clause* 4.3.1)

All dimensions in millimetres.

Nominal Cylinder Bore d_1	Radial Wall Thickness a_1 *Max*	Ring Groove Root Diameter, D_1			
		Compression Ring		Oil Control Ring	
		Max	*Min*	*Max*	*Min*
(1)	(2)	(3)	(4)	(5)	(6)
30	1·35	26·620	26·370	—	—
32	1·45	28·408	28·158	—	—
34	1·55	30·198	29·946	—	—
35	1·55	31·190	30·940	—	—
36	1·6	32·084	31·834	—	—
38	1·7	33·872	33·622	—	—
40	1·8	35·660	35·410	—	—
42	1·85	37·548	37·298	—	—
44	1·95	39·336	39·086	—	—
45	2·0	40·230	39·980	—	—
46	2·05	41·124	40·874	—	—
48	2·1	43·012	42·762	—	—
50	2·2	44·800	44·550	43·800	43·550
52	2·3	46·588	46·338	45·588	45·338
53	2·35	47·482	47·232	46·482	46·232
54	2·4	48·376	48·126	47·376	47·126
55	2·4	49·370	49·120	48·370	48·120
56	2·45	50·264	50·014	49·264	49·014
58	2·55	52·052	51·802	51·052	50·802
60	2·65	53·840	53·590	52·840	52·590
62	2·7	55·728	55·478	54·728	54·478
63	2·75	56·622	56·372	55·622	55·372
64	2·8	57·516	57·266	56·516	56·266
65	2·85	58·410	58·160	57·410	57·160
66	2·9	59·304	59·054	58·304	58·054
67	2·9	60·298	60·048	59·298	59·048
68	2·95	61·192	60·942	60·192	59·942
70	3·05	62·980	62·730	61·980	61·730
72	3·15	64·768	64·518	63·768	63·518
74	3·2	66·656	66·406	65·656	65·406
75	3·25	67·550	67·300	66·550	66·300
76	3·3	68·444	68·194	67·444	67·194
78	3·4	70·232	69·982	69·232	68·982
80	3·45	72·120	71·870	71·120	70·870
82	3·55	73·908	73·658	72·908	72·658
84	3·65	75·696	75·446	74·696	74·446
85	3·7	76·590	76·340	75·590	75·340
86	3·7	77·584	77·334	76·584	76·334
88	3·8	79·372	79·122	78·372	78·122

(*Continued*)

TABLE 8 TYPICAL RING GROOVE ROOT DIAMETER SIZES IN RELATION TO NOMINAL CYLINDER BORE AND MAXIMUM RING RADIAL WALL THICKNESS — *Contd*

Nominal Cylinder Bore d_1	Radial Wall Thickness a_1 *Max*	Ring Groove Root Diameter, D_2			
		Compression Ring		Oil Control Ring	
		Max	*Min*	*Max*	*Min*
(1)	(2)	(3)	(4)	(5)	(6)
90	3·9	81·160	80 910	80·160	79·910
92	4·0	82 948	82·698	81·948	81·698
94	4·05	84·836	84 586	83·836	83·586
95	4·1	85·730	85·480	84·730	84 480
96	4·15	86·624	86·374	85·624	85·374
98	4·25	88·412	88 162	87·412	87·162
100	4·3	90·300	90·050	89·300	89·050
102	4·4	92·088	91·838	91·088	90·838
104	4 4	94·076	93 826	93·076	92·826
105	4 55	94 770	94 520	93·770	93 520
106	4·6	95·564	95 414	94 664	94 414
108	4 6	97 652	97·402	96 662	96 402
110	4·7	99 440	99 190	98·440	98·190
112	4·8	101·228	100 978	100·228	90·978
114	4 8	103 216	102 966	107·216	101·966
115	4·9	104·010	103·760	103·010	102·760
116	4·9	105 004	104·754	104·004	103·754
118	5 0	106·792	106 542	105 792	105 542
120	5 1	108·580	108·330	107·580	107·330
122	5 1	110·568	110 318	109·568	109 318
124	5 1	112 558	112 306	111 556	111 306
125	5 3	113·150	112 900	112·150	111·900
126	5·3	114 144	113·894	113·144	112·894
128	5·3	116 132	115 882	115 132	114 882
130	5 5	117 720	117·470	116·720	116 470
132	5 5	119·708	119 458	118·708	118 458
134	5 5	121 696	121·446	120·696	120 446
135	5·6	122 490	122 240	121·490	121 240
136	5·6	123 484	123·234	122 484	122 234
138	5·6	125 472	125·222	124·472	124·222
140	5·8	127 060	126·810	126 060	125·810
142	5·8	129·048	128·798	128 048	127·798
144	5 8	131·036	130 786	130·036	129 786
145	6 0	131·630	131.380	130·630	130 380
146	6·0	132·624	132 374	131·624	131 374
148	6·0	134 612	134 362	133·612	133·362
150	6·1	136·400	146·150	135·400	135·150
152	6·1	138·388	138·138	137·388	137·138
154	6 1	140·376	140·126	139·376	139·126
155	6·3	140 970	140·720	139 970	139·720
156	6·3	141·964	141·714	140 964	140 714
158	6·3	143 952	143·702	142·952	142 702
160	6·5	145·540	145 290	144 540	144 290
162	6·5	147 528	147 278	146 528	146 278
164	6·5	149·516	149 266	148·516	148·266
165	6 6	150 310	150 060	149·310	149·060
166	6 6	151 304	151 054	150 304	150·054
168	6 6	153 292	153 042	152 292	152·042
170	6 8	154 880	154 630	153 880	153 630
172	6 8	156 868	156 618	155 868	155·618
174	6·8	158·856	158 606	157 856	157·606
175	7·05	159·350	159 100	158 350	158·100
176	7·05	160·344	160 094	159·344	159·094
178	7·05	162·332	162·082	161 332	161·082

(Continued)

TABLE 8 TYPICAL RING GROOVE ROOT DIAMETER SIZES IN RELATION TO NOMINAL CYLINDER BORE AND MAXIMUM RING RADIAL WALL THICKNESS — *Contd*

Nominal Cylinder Bore d_1	Radial Wall Thickness a_1 *Max*	Ring Groove Root Diameter D_1			
		Compression Ring		Oil Control Ring	
		Max	*Min*	*Max*	*Min*
(1)	(2)	(3)	(4)	(5)	(6)
180	7·25	163·920	163·670	162·920	162·670
182	7·25	165·908	165·658	164·908	164·658
184	7·25	167·896	167·646	166·896	166·646
185	7·35	168·690	168·440	167·690	167·440
186	7·35	169·684	169·434	168·684	168·434
188	7·35	171·672	171·422	170·672	170·422
190	7·55	173·260	173·010	172·260	172·010
192	7·55	175·248	174·998	173·248	173·998
194	7·55	177·236	176·986	176·236	175·986
195	7·65	178·030	177·780	177·030	176·780
196	7·65	179·024	178·774	178·034	177·774
198	7·65	181·012	180·762	180·012	179·762
200	7·65	182·600	182·350	181·600	181·350

Note — For unspecified diameters the formula given in 4.3.1 shall be followed.

5. Surface Finish

5.1 The outer surface of the piston shall be fine-machined, preferably by diamond turning or alternately by fine grinding. When not specifically stated, the recommended surface finish for piston skirt and ring zone shall be 1·6 to 3·2 µm R_a.

5.1.1 For relationship between R_a and R_t values for finished machined piston, reference may be made to the comparative chart given below:

R_t Value µm	Equivalent R_a Value µm	R_t Value µm	Equivalent R_a Value µm
0·08	0·025	8·00	2·540
0·16	0·050	8·80	2·794
0·24	0·076	9·60	3·048
0·32	0·101	10·40	3·302
0·40	0·127	11·20	3·556
0·48	0·152	12·00	3·810
0·56	0·177	12·80	4·064
0·64	0·203	13·60	4·318
0·74	0·228	14·40	4·572
0·80	0·254	15·20	4·826
1·20	0·381	16·00	5·080
1·60	0·508	20·00	6·350
2·00	0·635	24·00	7·620
2·40	0·762	28·00	8·890
2·80	0·889	32·00	10·160
3·20	1·016	36·00	11·430
3·60	1·143	40·00	12·700
4·00	1·270	44·00	13·970
4·40	1·397	48·00	15·240
4·80	1·524	52·00	16·510
5·20	1·651	56·00	17·780
5·60	1·778	60·00	19·050
6·00	1·905	64·00	20·320
6·40	2·032	68·00	21·590
6·80	2·159	72·00	22·860
7·20	2·286	76·00	24·130
7·60	2·413	80·00	25·400

Note 1 — The present practice in the country is to use both CLA (Ra) and crest to trough (Rt) methods for determining surface roughness of pistons. At present there is no general formula to express the relationship between the Ra and Rt values of surface roughness as the conversion varies with type of material, manufacturing process, etc.

Note 2 — The mean values of surface roughness measured on CLA scale are not mathematically convertible with depth of roughness values Rt.

Note 3 — The values are based on experience and experimentation on the sine curve profile basis and are valid for normal machining methods, such as turning, grinding, shaping and lapping with an accuracy range of ±15 percent.

5.2 The piston ring grooves shall be finished to a high degree of accuracy with regard to taper and waviness and shall have a fine surface finish on the side face. The recommended accuracies and finish are as follows:

Taper : ±7′ *Max*

Waviness : 0·025 mm *Max* (TIR) (Not to exceed 0·008 mm over a peripheral length of 25 mm)

Surface finish : 0·4 µm R_a

5.3 The gudgeon pin hole shall be fine finished preferably by boring with diamond tipped tools and shall have a high degree of accuracy in respect of ovality, taper and angularity to the piston axis. Recommended finish and accuracies are:

Pin hole finish : 0·3 µm R_a

Ovality and taper : 0·003 mm *Max*

Angularity of pin axis to piston axis : 0·10 mm TIR per 100 mm of measuring length

5.4 The concentricity of groove root and the ring zone with respect to piston axis shall be as follows:

Groove root concentricity : 0·15 mm (TIR) for piston up to 80 mm diameter
0·20 mm (TIR) for pistons above 80 mm up to 180 mm diameter
0·30 mm (TIR) for pistons above 180 mm diameter

Ring zone concentricity : 0·04 mm (TIR) for pistons up to 180 mm diameter
0·06 mm (TIR) for pistons above 180 mm diameter

6. Surface Treatment — Pistons may be tin coated, anodized or graphite coated partially or on whole surface according to the requirements of the engine which shall be decided between the purchaser and the manufacturer.

7. Tests

7.1 All pistons shall be examined visually for any defects of material, workmanship and finish. Minor material defects, harmless to the performance of the piston shall be acceptable as agreed to between the purchaser and the manufacturer.

7.2 The piston castings shall be checked by the manufacturer to conform to the hardness range given in **2.3**. For minimum distortion of the piston in the process of hardness checking, it is recommended to check hardness on Rockwell 'B' principle using 5 mm dia ball and a load of 250 kg. The equivalent Brinell hardness can be obtained from Table 1 (*see* **2.3.1**) The average of minimum of three readings shall be taken on the most stable portion of the crown. Certain piston designs involving thin sections are liable to give incorrect hardness value owing to deformation of the entire piston under load. For such pistons, the hardnees shall be measured on the cast/forged blanks. The method of testing for such pistons at the users' end and the permissible deviation for deformation shall be mutually agreed to between the purchaser and the manufacturer.

7.3 *Dimensional Check* — The dimensional characteristics given under Appendix C shall as be agreed to between the purchaser and the manufacturer according to the application and shall be checked by the manufacturer on 100 percent basis for all pistons using instruments of suitable accuracies.

7.3.1 For running surfaces with coated layers for running-in, the dimensions shall conform to specifications on the finish machined pistons without taking into account the thickness of the surface coatings.

7.3.2 Any non-destructive testing method may also be employed, depending on the type of piston applications and as per agreement between the purchaser and the supplier.

8. Marking — Each piston shall have the following minimum markings:

a) Manufacturer's name or trade-mark;

b) Nominal piston diameter;

c) Whether 'STANDARD' or 'OVERSIZE' and the oversize dimension wherever applicable;

d) Cold clearance (mandatory for replacement market); and

e) 'FRONT' or an arrow marking, wherever applicable.

8.1 Any other marking which may be called for by virtue of design or agreement between the purchaser and the manufacturer, may also be incorporated.

8.1.1 *Standard mark* — Details available with the Bureau of Indian Standards.

9. Packing — Each piston shall be coated with suitable anti-corrosive substance and packed in non-absorbent paper. Each set of pistons may then be securely packed in a suitable carton. The cartons may be further packed securely in woodon crates

9.1 The cortons containing the pistons shall indicate type of engine, model, number of pistons, nominal piston diameter and manufacturer's name.

10. Sampling — Unless otherwise agreed upon between the purchaser and the supplier the sampling inspection shall be in accordance with IS : 2500 (*Part I*)-1973 *'Sampling inspection tables: Part I* Inspection by attributes and by count of defects (*first revision*)'.

APPENDIX A

(*Clause* 3.1)

PISTON TYPE AND PISTON PART NOMENCLATURE

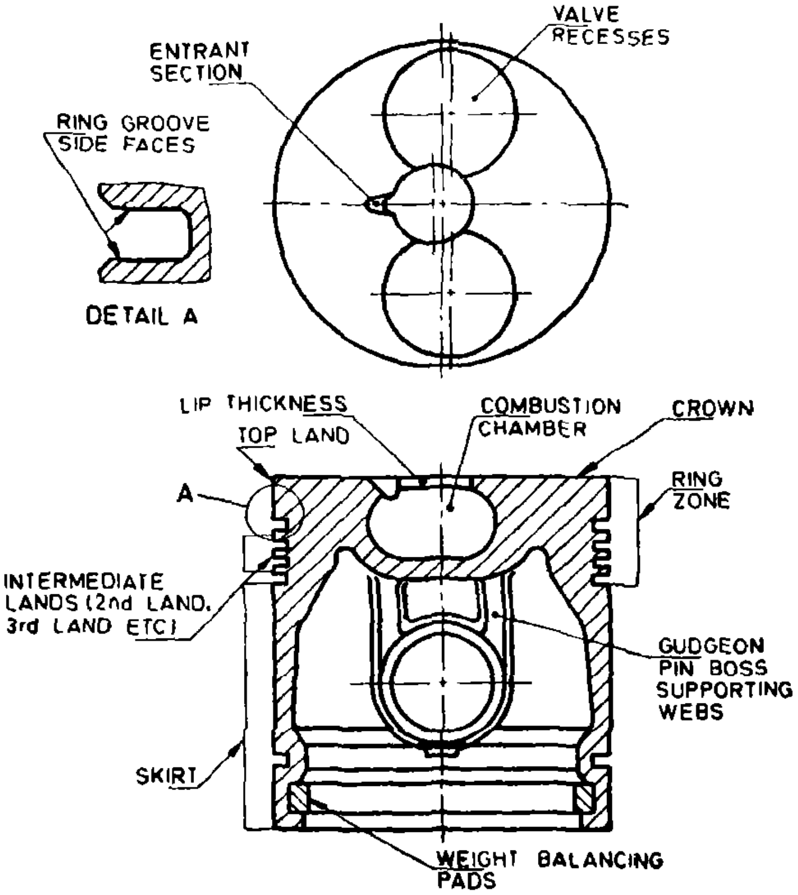


FIG. 1 SOLID SKIRT PISTON

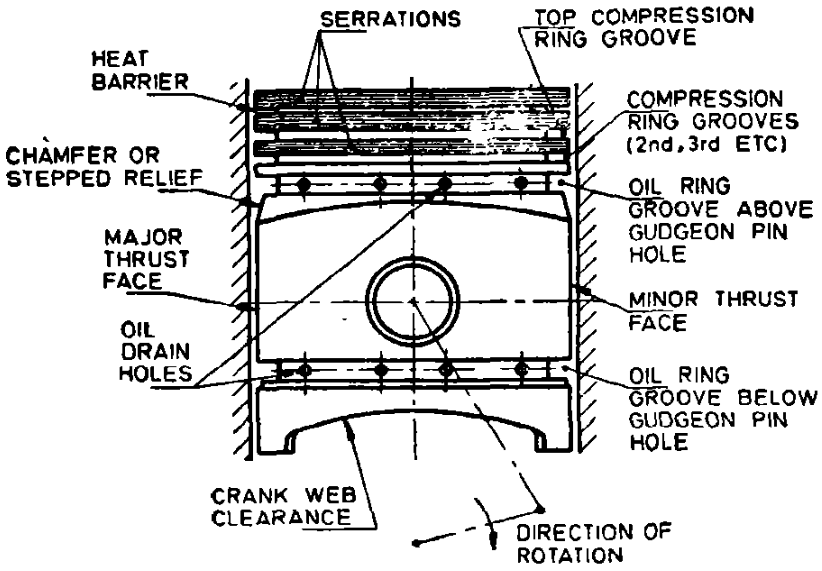

SERRATIONS
TOP COMPRESSION RING GROOVE
HEAT BARRIER
COMPRESSION RING GROOVES (2nd, 3rd ETC)
CHAMFER OR STEPPED RELIEF
OIL RING GROOVE ABOVE GUDGEON PIN HOLE
MAJOR THRUST FACE
MINOR THRUST FACE
OIL DRAIN HOLES
OIL RING GROOVE BELOW GUDGEON PIN HOLE
CRANK WEB CLEARANCE
DIRECTION OF ROTATION

FIG. 2 SOLID SKIRT PISTON WITH CRANK WEB CLEARANCE AT SKIRT END

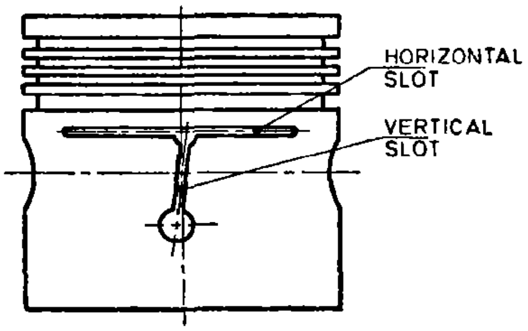


FIG. 3 SLOTTED SKIRT PISTON

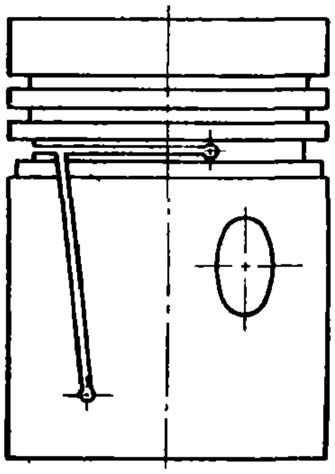


FIG. 4 TEE-SLOT PISTON

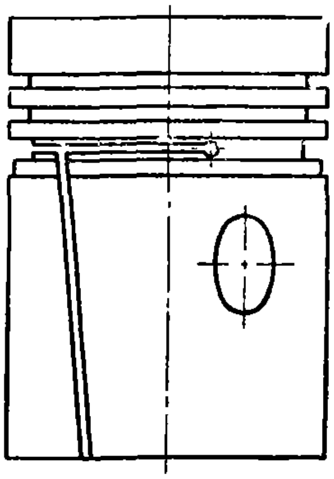


FIG. 5 SPLIT-SKIRT PISTON

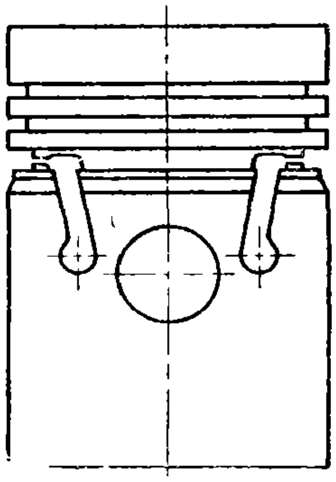


FIG. 6 W-SLOT PISTON

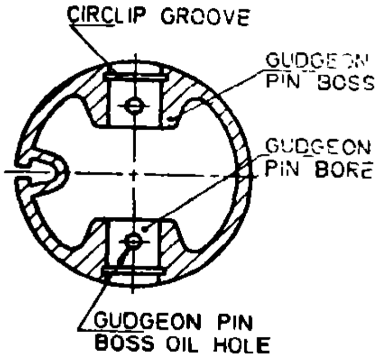


FIG. 7 SLOTTED SKIRT PISTON WITH V-RIBS

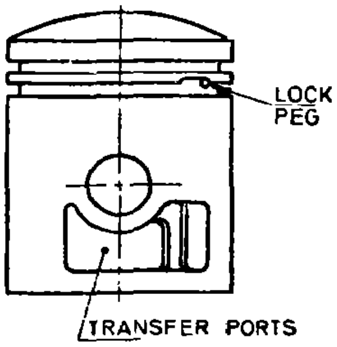


FIG. 8 TWO STROKE PISTON WITH TRANSFER PORTS IN SKIRT

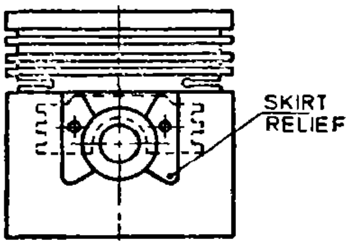


FIG. 9 STEEL STRUT PISTON WITH HORIZONTAL SLOT

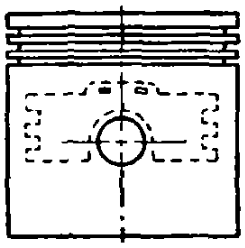


FIG. 10 STEEL STRUT PISTON WITHOUT HORIZONTAL SLOT

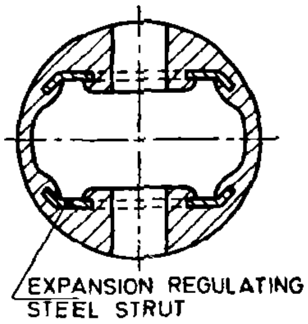


FIG. 11 FULL SKIRT STEEL STRUT PISTON WITH HORIZONTAL SLOT

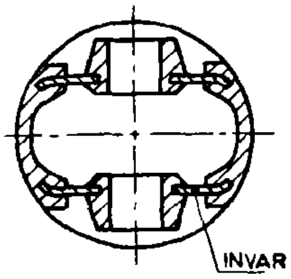


FIG. 12 INVAR STRUT PISTON

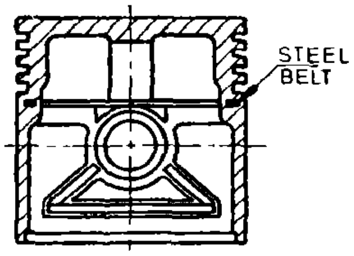


FIG. 13 ISOSTATIC PISTON

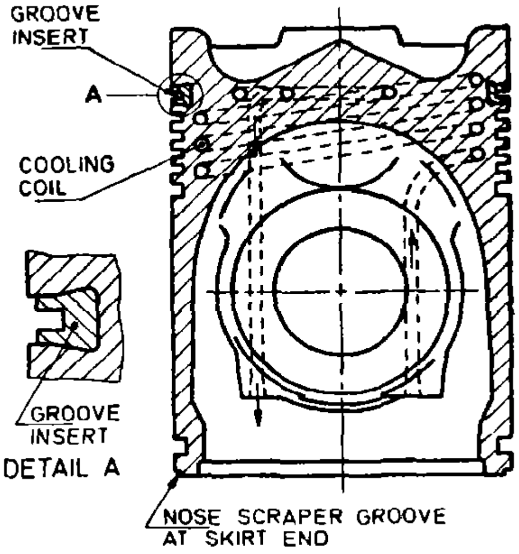


FIG. 14 PISTON WITH CAST IN COOLING COIL

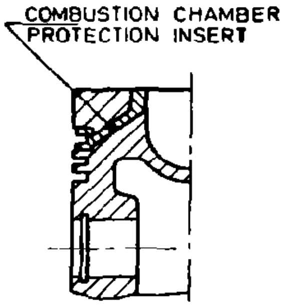


FIG 15 GROOVE INSERT WITH COMBUSTION CHAMBER PROTECTION

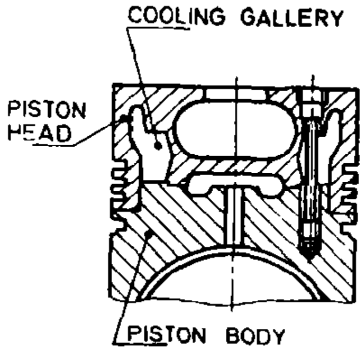


FIG. 16 COMPOSITE PISTON

APPENDIX B

(*Clause* 3.2)

PISTON DIMENSION NOMENCLATURE (*see* Fig. 17, 18 and 19)

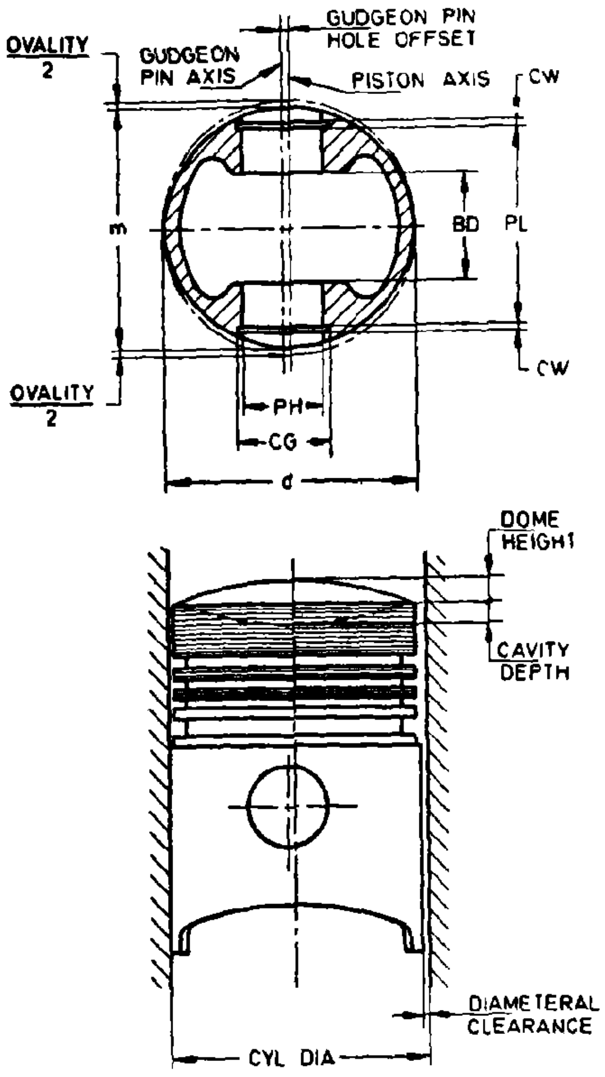
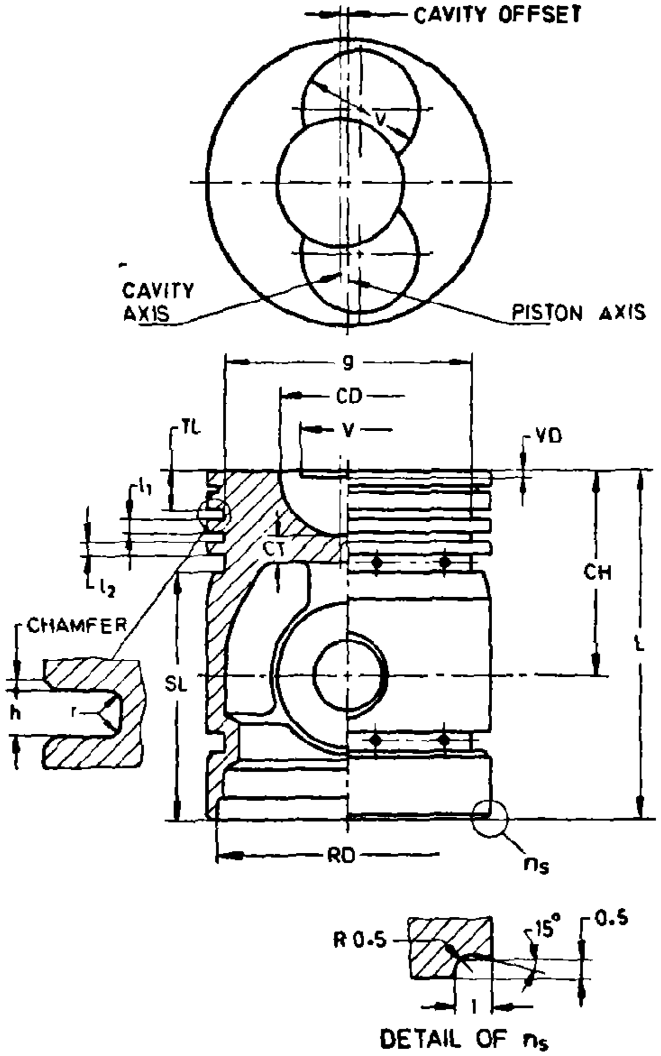
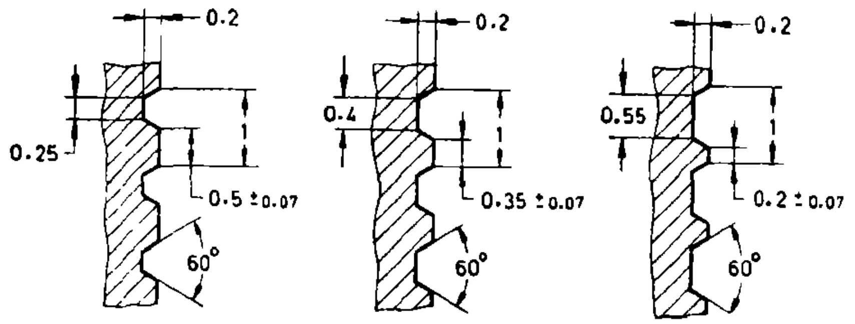


FIG. 17



All dimensions in millimetres.

FIG. 18



All dimensions in millimetres.

FIG. 19 STANDARD SERRATIONS

Cyl. dia	— Cylinder bore diameter
d	— Piston major diameter
m	— Piston minor diameters
Play	— Nominal diametral clearance (cold)
Ovality	— Piston ovality = (*d*—*m*)
g	— Groove root diameter
r	— Groove root radius
h	— Ring groove axial width
Chamfer	— Ring groove chamfer
CH	— Compression height
L	— Total length of piston
SL	— Skirt length
n_s	— Nose scraper groove at skirt end
RD	— Register diameter (turning fixture diameter)
TL	— Top land height
t_1	— Height of first land (land immediately below the top compression ring)
t_2	— Height of second land
t_3, etc	— Height of third land, etc
CD	— Cavity diameter
BD	— Gudgeon pin boss distance
PH	— Gudgeon pin hole diameter
CG	— Circlip groove ground diameter
CW	— Circlip groove width
PL	— Distance between circlip grooves
CT	— Crown thickness
V	— Valve recess diameters
VD	— Valve recess depth

APPENDIX C

(*Clause* 3.3)

RECOMMENDED TOLERANCES ON ESSENTIAL CHARACTERISTICS OF PISTON

Sl No. *Characteristic* *Tolerance* mm

1. Piston diameter:

		Ring Zone	Skirt
30 to 50 mm	:	0 −0·050	0 −0·030
50 to 80 mm	:	0 −0·060	0 −0·030
80 to 100 mm	:	0 −0·075	0 −0·030
100 to 120 mm	:	0 −0·090	0 −0·040
120 to 180 mm	:	0 −0·120	0 −0·040

Note — The piston diameters may be graded for selective assembly as agreed to between the manufacturer and the purchaser.

2. Groove root diameter:
   - a) Normal rings : 0 / −0·25
   - b) Expander rings (where ring load depends on root dia) : ±0·1
3. Groove root radius : ±0·15
4. Ring groove axial width : Depending on axial clearance desired
5. Trapezoidal grooves (*see* Fig. 20):
   - a) Reference diameter : (Cylinder diameter — 3 mm)
   - b) Groove axial width (H_1) : Controlled at reference diameter

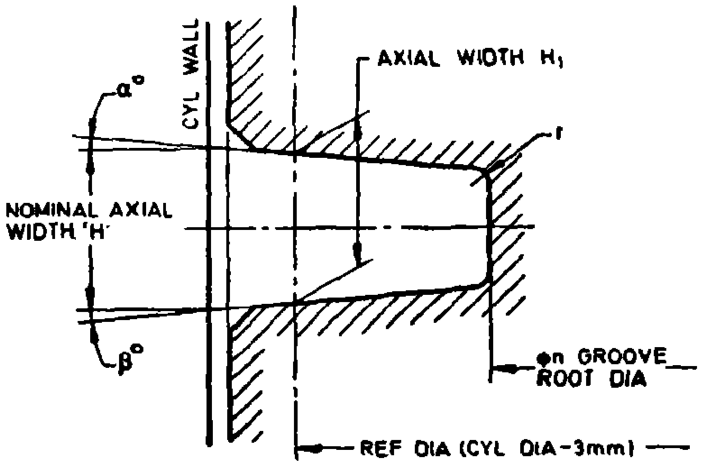


FIG. 20 TAPER GROOVES

   - c) Tolerance on groove axial width (H_1)* : ±0·015
   - d) Nominal groove axial width (H) : As calculated from H_1 and angles α and β

---

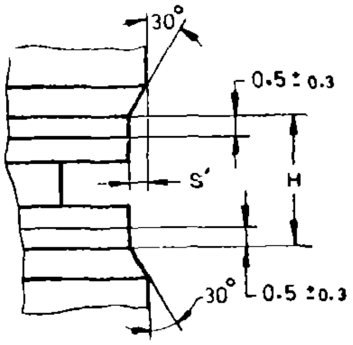
*Difference in nominal dimensions between groove and ring at measuring point 1·5 mm from bore takes care of minimum clearance.

Sl No.	*Characteristic*	*Tolerance* mm
	e) Tolerance on angle of upper and lower flank 'α and β'	±6'
	f) Tolerance on nominal (0·3 or 0·5) groove root radius	±0·15
	g) Ring groove root concentricity to piston longitudinal axis	
	i) For included angles α and β up to 10°	0·15 (TIR)
	ii) For included angles α and β over 10°	0·10 (TIR)

Note 1 — Measurements are taken with the help of special instrument having rollers and dial comparator.

Note 2 — Other specific details if any shall be subject to agreement between the purchaser and the manufacturer.

6.	Groove machined in alloyed cast-iron groove-inserts (*see* Fig. 21)	
	a) Groove insert machining details	



All dimensions in millimetres.

FIG. 21 MACHINED GROOVES

	i) *S'*, Set back	As minimum as possible. (The groove-insert should be machined with same profile as the piston outer dia in that region)
	ii) *H* Groove insert axial height	+1 mm
	b) Concentricity of recess to adjoining lands	
	Piston Diameter mm	
	i) Up to 80	0·15 mm
	ii) Above 80 up to 180	0·20 mm
	iii) Above 180	0·30 mm
	c) Surface finish of the groove side-faces	2·25 μm R_a

Note — Tolerances for other parameters will be same as those for normal grooves.

7	Piston ovality*	±0·015

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*For specific designs, this tolerance may be increased to ±0·020 subject to agreement between the purchaser and the manufacturer.

Sl No. *Characteristic* *Tolerance* mm

8. Compression height:
   - a) Petrol engines : ±0·1
   - b) Diesel engines : ±0·05

Note — Pistons with finish cast crowns can have higher tolerance subject to agreement between the manufacturer and the purchaser.

9. Top land width : ±0·1

10. Width of intermediate lands:
    - a) Up to 3 mm : ±0·1
    - b) From 3 up to 4 mm : ±0·15
    - c) Above 4 mm : ±0·2

11. Crown thickness:
    - a) Normal : ±0·15
    - b) Critical : $^{+0·2}_{\ \ 0}$

12. *Gudgeon pin boss distance:*

    Piston Diameter mm
    - a) Up to 75 : ±0·3
    - b) Above 75 up to 140 : ±0·5
    - c) Above 140 : ±0·8

Note — Engine designs demanding closer tolerances may be negotiated between the purchaser and the manufacturer.

13. Gudgeon pin hole diameter : Depending on gudgeon pin fit desired

14. Circlip grooves :

Circlip Type	Seegar	Wire
Dia	H12	+0·15
Width	+0·2	+0·05

15. Distance between circlip grooves : $^{+0·2}_{\ \ 0}$

16. Open tolerances:
    - a) Cast finish : ±0·3 mm
    - b) Linear dimensions : ±0·25 mm
    - c) Angular dimensions : ±1°

17. Weight and tolerance for weight of pistons shall be mutually agreed to between the purchaser and the manufacturer, depending on the engine requirements.

EXPLANATORY NOTE

This Indian Standard was first issued in 1977. In this revision, the ring groove dimensions and clearances, the method for calculating the groove root diameters, etc, have been included. Typical values of groove root diameters in relation to the nominal cylinder bore and the maximum radial wall thickness are given in tables. In addition, ring groove widths in relation to cylinder bore diameters and ring widths have been specified.

The technical supply conditions for pistons rings are covered in IS : 5791-1986 (*first revision*).

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the results shall be rounded off in accordance with IS : 2 - 1960 'Rules for rounding off numerical values (*revised*)

While preparing this standard assistance has been derived from BS : 5341 (Part 5)-1976 'Specification for piston rings up to 200 mm diameter for RIC engines — Part 5 Ring groove', issued by British Standards Institution.

Printed at Dee Kay Printers, New Delhi, India